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FEW 320

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ABSTRACT

The paper focuses on the role of a capital shortage in explaining protacted periods of unemployment in a small open economy. Applying a macroeconomic model with micro foundations it is shown that under nominal wage rigidity adverse demand shocks may lead to a rather long period of unemployment when capital accumulation is taken into account. Under real wage rigidity adverse demand shocks raise the equilibrium rate of unemployment, because firms prevent rises in real producers' wages by contractions in capacity. The results of the model appear to be sensitive for changes in the elasticity of factor substitution. The steady state properties of the model are analysed analytically, while the impact and transient effects are studied with the aid of numerical examples, which are based on a multiple shooting algorithm.

*1. INTRODUCTION**

The high and sustained level of unemployment in many European countries is well-known and needs hardly further documentation. Moreover, there seems to be some kind of consensus that the NAIRU has increased along with the rise in actual unemployment. An increase in the NAIRU can be explained as the result of unfavourable supply shocks and adverse demand shocks (increasing the wedge between the producers' and consumers' real wage) when labour unions resist real wage adjustments (e.g. Layard and Nickell, 1986, 1987; Sachs, 1987). Recently it has been argued that the NAIRU itself is influenced by the time path of actual employment. Such "hysteresis" (i.e. path-dependency) effects may be caused by insiders becoming outsiders (see Blanchard and Summers, 1986, 1987) or may be the result of a rise in the number of long-term unemployed ("duration" theory, e.g. Nickell, 1987). Although the role of capital is acknowledged these studies with a few exceptions (Bruno and Sachs, 1985; Burda, 1987; Van der Ploeg, 1987) do not pay much attention to the process of capital accumulation itself. Changes in employment are explained as movements along the short-run labour demand schedule. Reductions in the capital stock are conceived as adverse supply shocks affecting the demand for labour just like other unfavourable events. The idea that the existing capital stock may be inadequate to employ the current labour force ("capacity" theory) is generally associated with limited substitution possibilities at least in the short run (e.g. Malinvaud 1982; Drèze and Sneessens, 1986).

The objective of this paper is to focus on the role of capital accumulation ("capacity" theory) in explaining long-lasting unemployment in a small open economy. Taking the Lucas' critique of policy evaluation into account it is assumed that households and firms are guided by rational expectations (perfect foresight). Labour-market adjustment takes time because of nominal or real wage rigidity. The paper builds upon the model in Van de Klundert and Van der Ploeg (1987, 1988), which is extended to allow for capital accumulation and different elasticities of substitution. It will be shown that adverse demand shocks, which have been predominant in Europe in the eighties, may lead to protracted periods of unemployment even under nominal wage rigidity. Moreover if labour unions base their policy on a target real consumers' wage rate adverse demand shocks may induce an increase in the equilibrium rate of unemployment without affecting the real producers' wage. Under these circumstances there may be a more or less sustained level of unemployment all along the adjustment path with real producers' wages too high in the first phase and

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reductions in capacity gradually taking over afterwards. As will be illustrated these quantitative results are sensitive with respect to the elasticity of factor substitution.

The paper is organized as follows. The micro foundations of the macroeconomic model are presented in Section 2. In Section 2.1 infinitely-lived households decide on present and future consumption of domestic and foreign goods, which are imperfect substitutes, and allocate savings among real cash balances, traded and non-traded bonds. The behaviour of profit maximizing firms which demand labour and buy investment goods is analysed in Section 2.2. Equilibrium in assets markets and in the market for commodities is dealth with in Section 2.3. The situation on the labour market requires special attention. In Section 2.4 a distinction is made between nominal and real wage rigidity. In addition the role played by labour unions is given some consideration. Solutions of the complete model are the main point in Section 3. Steady-state properties of the system are analysed in Section 3.1. Numerical simulations based on a multiple shooting algorithm are presented in Sections 3.2 and 3.3. In Section 3.2 the effects of a reduction in government expenditure under nominal and real wage rigidity are shown, whereas in Section 3.3 the sensitivity of the results with respect to the elasticity of factor substitution is discussed. The paper closes with some conclusions on the problem of unemployment in a small open economy.

2. MICRO FOUNDATIONS OF THE MACROECONOMIC MODEL

In this section an optimizing model of a small open economy is derived in general terms. The specification of the functions introduced is given in the Appendix along with the values of the parameters used in numerical simulations.

2.1. Consumers

Consumers maximize the present value of a utility stream with utility depending on consumption of domestic goods (c_d), foreign or imported goods (c_m) and real cash balances. The supply of labour is assumed exogenous. A justification for entering real money in the utility function is presented in Feenstra (1986). Assuming intertemporal separability the decision problem households face can be split up in two stages. In the first stage the household decides on its aggregate consumption and portfolio selection. The latter problem relates to a choice from the asset menu consisting of domestic currency, traded bonds and non-traded bonds. In the second stage the household decides how to divide aggregate consumption into consumption of home goods and foreign goods.

Real variables can be defined in different ways depending on how nominal variables are deflated. Here we distinguish real variables (indicated with a tilde) obtained by applying a consumer price index (P_c) from real variables (without a tilde) obtained by applying the domestic price index (P). Denoting aggregate real consumption by $\tilde{c}$ $(= c \dfrac{P}{P_c})$, real money balances by $\tilde{m}$ $(= m \dfrac{P}{P_c})$, real traded bonds by b and real non-traded bonds by a the first stage decision problem can be formulated as:

$$(1) \qquad \underset{\{\tilde{c}, \tilde{m}, b, a\}}{Max.} \int_0^\infty e^{-\sigma t} \{ u_1(\tilde{c}) + u_2(\tilde{m}) \} \, dt$$

Subject to the intertemporal budget constraint

$$(2) \qquad \dot{m} + \dot{a} + \dot{b} = (r - p)\, a + (r^* - p + e)\, b + y_n - c - pm - (1/2 \;\psi\, b^2)$$

and initial conditions with regard to m, a and b.

Consumers take as given the following quantities:

r = domestic nominal rate of interest
r^* = foreign nominal rate of interest
p = domestic rate of inflation (P = domestic price level)
p^* = foreign rate of inflation (P^* = foreign price level)
e = rate of exchange depreciation (E^* = nominal exchange rate)
y_n = income (y) net of (lump-sum) taxes (τ)

The budget constraint (2) includes a risk premium $1/2\; \psi\, b^2$ on traded bonds where ψ depends on the degree of risk aversion and the variance of exchange risk (see Turnovsky, 1985). Instantaneous utility in (1) is separable in aggregate consumption and real cash balances, implying that the real part of the model is separated from the nominal part which is assumed for convenience. The problem can be solved by applying standard methods. Denoting the adjoint or costate variable by μ the first-order conditions for an optimum read:

(3) $$u_1'(\bar{c}) = \mu \frac{P_c}{P}$$

(4) $$\dot{\mu} - \sigma\mu = -u_2'(\bar{m})\frac{P}{P_c} + p\mu$$

(5) $$\dot{\mu} - \sigma\mu = -\mu(r - p)$$

(6) $$\dot{\mu} - \sigma\mu = -\mu(r^* - p - e) + \mu\psi b$$

, and the usual transversality conditions.

Equation (3) can be rewritten as the aggregate consumption function. The demand for money follows from equations (4) and (5):

(7) $$u_2'(\bar{m}) = r\,\mu\,\frac{P_c}{P}$$

As appears from equations (3) and (7) the marginal rate of substitution between commodities and real cash balances is equal to the domestic nominal interest rate.

Combination of equations (5) and (6) gives an expression for traded bonds:

(8) $$b = \frac{1}{\psi}(r^* + e - r)$$

The "tilt" of the consumption function is given by equations (5), which determines the jump-variable μ.

The second-stage decision problem of households can be written as

(9) $$\underset{\{c_d, c_m,\}}{Max.} \quad v = v(c_d, c_m)$$

subject to the budget constraint:

(10) $c_d + \nu c_m = c,$

, where $\nu = \dfrac{P^*E}{P}$ denotes the real exchange rate. The utility function is homothethic by assumption. The first-order condition is:

(11) $v_{cm}/v_{cd} = \nu$

The marginal rate of substitution between domestic and foreign goods must be equal to the real exchange rate. Equations (10) and (11) taken together yield:

(12) $c_m = \Phi(\nu)\, c, \quad \Phi'<0$

(13) $c_d = \{1 - \nu\Phi(\nu)\}\, c$

A real exchange rate depreciation leads to a decline in imports, while the effect on the consumption of domestic goods may go either way, because the income effect and the substitution effect have opposite signs. Substitution of these solutions in the utility function (9) gives the indirect utility function, which can be rearranged to define the ideal definition of the cost of living as:

(14) $\dfrac{P_c}{P} = \dfrac{1}{v\{(1-\nu\Phi(\nu)),\Phi(\nu)\}} \equiv \Omega(\nu), \qquad \Omega' > 0$

A depreciation of the real exchange rate induces a rise in the costs of living index.

2.2. Firms

Output (x) is non-storable and can be produced by a neo-classical production function in labour (l) and capital (k) with constant returns to scale:

(15) $\quad x = f(k,l), \qquad f_l, f_k, f_{kl} > 0, \ f_{ll}, f_{kk} < 0$

Capital accumulation depends on gross investment (i) and depreciation which is at an exponential rate (δ)

(16) $\quad \dot{k} = i - \delta k$

To derive a well-behaved investment function installation cost are introduced following among others Hayashi (1982). The investment expenditure function including accumulation and installation cost is written as:

(17) $\quad h = h\,(i, k)\ , \qquad h_i > 0\ ,\ h_k < 0\ ,\ h_{ii} > 0$

Firms maximize the present value of the cash flow subject to the constraints in equations (15), (16) and (17) and given the time paths of real wages (w) and the interest rate (r). Denoting the discount factor by $\omega(t) = \exp\ \{-\int_0^t (r_s - p_s)\, ds\}$ the problem reads:

(18) $$\underset{\{l,i\}}{Max.} \quad V = \int_0^\infty \omega(t)\ \{\, f\,(k,l) - wl - h\,(i,k)\}\, dt$$

subject to equation (16) and an initial condition for k. Denoting the costate variable associated with capital by q and applying standard solution methods gives the first-order conditions for a maximum as:

(19) $\quad f_l\,(k,l) = w$

(20) $\quad h_i\,(i,k) = q$

(21) $\quad \dot{q} = (r - p - \delta)q - f_k\,(k,l) + h_k\,(i,k)$

Equation (19) can be rewritten to give the demand for labour by the profit maximizing firm. Equation (20) can be interpreted as Tobin's q theory of investment. Integration of equation (21) gives the value of q as a discounted stream of gross marginal products of capital:

(22) $$q_0 = \int_0^{\infty} (f_k - h_k)\, e^{-\int_0^t (r_s - p_s + \delta) ds}\, dt$$

2.3. Market equilibirum: assets and goods

The supply of money grows at a given rate (θ). Equating the demand for real cash balances with the supply of money in real terms results in:

(23) $$\dot{m} = (\theta - p)\, m$$

The amount of non-traded bonds (a) is assumed constant and the government finances real expenditure (g) and interest payments by collecting lump-sum taxes. The government budget constraint can therefore be ignored. The demand for traded-bonds (b) which is determined by equation (8) should be equal to the supply of traded-bonds, which is a predetermined variable. Changes in the stock of traded-bonds are governed by the balance of payments on current account.

(24) $$\dot{b} = f(k,l) - c - g - h(i,k) + (r^* + e - p)b$$

Equilibrium in the domestic goods market requires:

(25) $$f(k,l) = c_d + g + h(i,k) + c_m^*$$

, where c_m^* denotes foreign demand for home goods (exports). By analogy with the import equation (12) exports are given by

(26) $$c_m^* = \Phi^*(\nu)c^*, \qquad \Phi^{*\prime}>0$$

Foreign aggregate consumption (c^*) is treated as exogenous in a small open economy. Finally, it should be observed that government spending and investment outlays fall entirely on the domestic good.

2.4. Labour market disequilibrium

It is assumed that there is some form of wage inertia. In the case of nominal wage rigidity (NWR) this can be described by an inflation augmented Phillips-curve of the usual type:

$$(27) \qquad \frac{\dot{w}}{w} + p = \phi\,(l_s - l) + \theta, \quad \phi' < 0, \quad \phi'' > 0, \quad \phi\,(u_n) = 0$$

, where l_s denotes exogenous labour supply and u_n denotes the natural rate of unemployment. It follows from (27) that households are always rationed when they sell labour and that firms are never rationed when they hire labour. The nominal wage rate is a predetermined variable.

In equilibrium $\dot{w} = 0$, $p = \theta$ and $l_s - l = u_n$; actual unemployment then equals the natural rate of unemployment. Note that the expected inflation term at the RHS of (27) corresponds to the growth rate of money. Although this may be restrictive it does not influence the main results. Alternatively, one could assume that expectations are adaptive, that is depend on a weighted average of past inflation rates (cf. Van de Klundert and Van der Ploeg, 1987). Under NWR the system returns to its initial equilibrium after being exposed to a shock, which does not affect the natural rate of unemployment. Taking capital accumulation into account the adjustment process may take some time and there could be a protracted period of unemployment following an adverse shock.

With real wage rigidity (RWR) prevailing there are long-run consequences of unfavourable supply shocks as well as of unfavourable demand shocks which eventually affect the real exchange rate. The point is that under RWR the equilibrium real wage rate changes on impact of shocks. A change in the equilibrium value of the real wage rate implies that the natural rate of employment or NAIRU changes. As has been demonstrated by Sachs (1987) RWR can be related to the behaviour of labour unions, which maximize some preference function in real wages and employment, subject to a labour demand equation. This line of reasoning is followed in several other papers (e.g. Layard and Nickell, 1986, 1987; Nickell, 1987). Here we take company with Hahn (1987) who casts some doubt on the trade-off unions are supposed to perform in the neo-classical conception. But even if unions make such decisions it does not make sense to leave capital accumulation completely out of the picture as is done in the studies mentioned above. Burda (1987) considers the accumulation problem, but in his model union behaviour is myopic. A more satisfactory treatment of the problem along neo-classical lines is presented in Van der Ploeg (1987). Here we shall assume that unions have a target real consumers' wage rate w_d but are willing to make concessions as unemployment emerges unexpectedly, that is unions learn from experience. Denoting the real consumers' wage by w_c these ideas can be given the following form:

$$(28) \quad \frac{\dot{w}_c}{w_c} = \phi\,(l_s - l) - \chi \log\,(\frac{w_c}{w_d})$$

The rate of change in consumers' real wages is by definition

$$(29) \quad \frac{\dot{w}_c}{w_c} = \frac{\dot{w}}{w} + p - p_c$$

Logarithmic differentiation of equation (14) with respect to time and substitution of the result in equation (29) gives:

$$(30) \quad \frac{\dot{w}_c}{w_c} = \frac{\dot{w}}{w} - \frac{\Omega'\nu}{\Omega}\frac{\dot{\nu}}{\nu}$$

Integration of equation (28) yields

$$(34) \quad \log\left(\frac{w_c(t)}{w_d}\right) = \log\left(\frac{w_c(0)}{w_d}\right) e^{-\chi t} + \int_0^t \phi\,(l_s - l)\, e^{\chi(s-t)} ds$$

This shows that under RWR the real wage rate recovers from past disequilibria in the labour market and gradually adjusts towards a long-run equilibrium value. It should be observed that w_d is an exogenous variable. In the next section it will be assumed that w_d equals the real consumers' wage rate in the initial steady state. Therefore, w_d reflects all past developments (shocks) which are fully digested at t=0. In this perhaps spurious sense the model exhibits the now popular hysteresis fenomena (e.g. Sachs, 1987; Blanchard and Summers, 1986, 1987).

3. ADVERSE DEMAND SHOCKS IN THE MACROECONOMIC FRAMEWORK

The complete model comprises the equations (3), (5), (7), (8), (13), (14), (15), (16), (19), (20), (21), (23), (24), (25), (26), and (27) under NWR, or (28) and (30) under RWR. These equations can be solved for the corresponding number of variables, viz. c, c_d, c_m*, m, r, p, e, ν, P_c/P, μ, b, k, q, i, l and w (in the case of NWR) or w and w_c (in the case of RWR). The steady state characteristics of the model are discussed in Section 3.1. To study the transient properties of the system we have recourse to numerical examples in Section 3.2. More specifically, attention will be paid to the effects of adverse demand shocks on unemployment in the short run as well as in the long run. The solutions are obtained with the aid of a multiple shooting algorithm (e.g. Lipton, et.al., 1982). The numerical values of the parameters, the exogenous variables, the initial conditions and the eigenvalues evaluated at the initial steady state are given in the Appendix. As will be clear the model satisfies the saddlepoint property since there are 3 positive roots associated with the jump variables m, μ, and q and 3 negative roots associated with the predetermined variables b, k and w/m or w_c. In Section 3.3 the sensitivity of the results for changes in the elasticity of factor substitution is discussed.

3.1. Steady state properties

In a steady state we have $\dot{\mu} = \dot{m} = \dot{b} = \dot{q} = \dot{k} = \dot{w} = \dot{\nu} = 0$. On the monetary side of the model this results in: $p = p_c = \theta$, $e = \theta - p^*$ and $r - \theta = \sigma$. The steady state rate of inflation is entirely a monetary event. The long-run solution for traded bonds follows immediately from equation (8):

(35) $$b = \frac{\sigma^* - \sigma}{\psi}$$

, where $\sigma^* = r^* - p^*$ is the foreign discount rate.

The steady-state version of equation (21) reads:

(36) $$(\sigma + \delta)\, q = f_k(k,l) - h_k(i,k)$$

It will be assumed that the installation cost per unit of the investment good are a function of $\frac{i}{k}$. Equation (17) can be rewritten as:

$$(37) \qquad h = i(1 + \bar{h}(\frac{i}{k})) \quad ,\bar{h}' > 0,\ \bar{h}'' > 0$$

As can be easily shown the derivation of (37) with respect to i and k are in this case a function of i/k only. In the steady state $i/k = \delta$ holds as appears from equation (16).
The long-run solution for q now follows from equation (20):

$$(38) \qquad q = h_i(\delta)$$

Substituting this equation in equation (36), taking the linear homogeneity of the production function into account, results in:

$$(39) \qquad f_k(\frac{l}{k}) = (\sigma + \delta)\, h_i\,(\delta) + h_k\,(\delta)$$

The steady state capital-labour ratio depends only on the subjective rate of time preference and the rate of depreciation of the capital stock (see Blanchard and Sachs, 1982; Van de Klundert and Peters, 1986). This is an important result as will become clear in the subsequent analysis.
Under NWR steady state employment follows from equation (27):

$$(40) \qquad l = l_s - u_n$$

As appears from equations (39) and (40) under NWR a demand shock does not affect the long-run outcomes of employment and capital. As a result production does not change. The situation is different with RWR. Combining equations (14) and (29) we get $w_c = \frac{w}{\Omega(\nu)}$. Substutition of this result and equation (19) in the steady state version of equation (28) gives:

$$(41) \qquad \phi\,(l_s - l) = \chi\left(\log\ f_l(\frac{k}{l}) - \log\{\Omega(\nu)\} - \log w_d\right)$$

Because $\phi' < 0$ and $\Omega' > 0$ equation (41) implies a negative relationship between employment (l) and the real exchange rate (ν). The corresponding positive relationship between l and P/EP^* can be interpreted as a long-run aggregate supply curve in a small open economy. To focus on the role of capital accumulation it may be worthwile to consider a long-run solution with a fixed capital stock. As appears from equation (41) the slope of the supply curve will be steeper in this case. The situation is illustrated in Figure 1. The aggregate supply curve with a constant stock of capital is the curve S_l, while the supply curve with both factors of production variable is indicated by S_{kl}. Both curves intersect in the point with coordinates determined by the initial long-run solution, i.e. point A in Figure 1. Fiscal policy is non-neutral under RWR as can be shown after deriv-

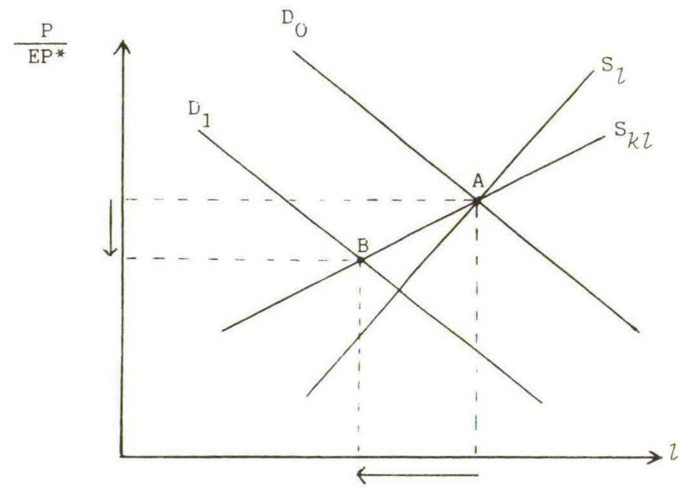

Figure 1

ing the aggregate demand curve.

Aggregate consumption in the steady state can be found from equation (24). To simplify things a bit we assume $\sigma = \sigma^*$ which implies $b = 0$ as can be seen from equation (35). The solution for c then reads:

(42) $\quad c = f(k,l) - g - h$

Substitution of equation (42) in equation (13) results in the long-run value for consumption of domestic goods. Substitution of the outcome for c_d and equation (26) in equation (25) gives:

$$(43) \qquad f(k,l) = \frac{\Phi^*(\nu)}{\nu\Phi(\nu)}c^* + g + h(k;\delta)$$

Taking $\Phi^{*\prime} > 0$ and $\Phi' < 0$ into account equation (43) implies a positive relationship between l and ν under the condition: $\frac{-\nu\Phi'}{\Phi} < 1$. Therefore, given that the marginal propensity to consume domestic goods is less than unity the aggregate demand curve slopes downward in $l - \frac{p}{P^*E}$ space as shown in Figure 1. The demand curve in the initial steady state is indicated by D_0. It should be noted that the aggregate demand curve is drawn for a constant $\frac{k}{l}$ ratio.

A reduction in government expenditure shifts the aggregate demand curve downward. The new long-run equilibrium is at point B in Figure 1. The real exchange rate (ν) depreciates and the level of employment falls. With RWR the depreciation of exchange rate increases the wedge between the producers' and consumers' real wage. A rise in w will lead *ceteris paribus* to a higher level of unemployment. But as firms face a decline in profitability they will reduce the stock of capital. Ultimately, the real producers' wage rate (w) does not change but unemployment will be reduced even further as illustrated in Figure 1. Firms shift the higher burden of an increase in the wedge backwards at the cost of capacity unemployment (see Burda, 1987).

Equations (41) and (43) can be applied to other shocks as well. The solution for l in the case of RWR can be given in implicit form as:

$$(44) \qquad l = l(\overset{+}{g}, \overset{+}{c^*}, \overset{-}{w_d}, \overset{-}{u_n})$$

Fiscal expansion is effective in the long run under RWR. A change in foreign demand (c^*) has also a positive effect on employment. Supply-side policies which reduce the natural rate of unemployment (u_n) induce a higher level of employment. The same conclusion holds for a reduction in the target level of the real consumers' wage (w_d).

3.2. Fiscal contraction: a numerical example

The results of a reduction in government expenditure by 1.7 % in terms of GNP are presented in Table 1 (for NWR) and Table 2 (for RWR). On *impact* a fiscal contraction leads to a fall in the price of the domestic good, which will be in excess supply after the shock. A lower price of home goods shows up in a rise of real cash balances. With NWR the real producers' wage increases to the full extent of the fall in domestic prices, because the nominal wage rate does not change in the first period. As a result employment and output decline. Despite the fall in output consumption increases as the government spends less (crowding-in). The real exchange rate depreciates as domestic goods become more abandant *vis-a-vis* foreign goods. Export rises and imports are discouraged in favour of home goods.

The *dynamic* development with NWR is governed by two opposite forces. First, unemployment induces a fall in nominal and through that real wages over time (the Phillips-curve effect), which leads to a rise in employment. Second, high real wages set a process of capital decumulation into motion, which leads to a fall in employment. As appears from Table 1 the Phillips-curve effect dominates the capacity effect. It should be observed in this connection that as a result of decapitalization wages decline extra. Eventually, real wages fall below the level at the initial steady state as can be seen at t = 10 in Table 1. Such an undershooting is typical for an economy in which jobs get lost, because capacity is wiped out to a certain extent.

In the *long run* the system returns to a new steady state (NSS) with full employment and the capital stock back at its initial level. The rise in private consumption then corresponds to the decline in government expenditure. The real exchange rate depreciates compared with the initial steady state because private consumption leads also to a higher demand for imports while government expenditure falls entirely on domestic goods as is assumed in the model.

Under RWR the impact effect of a rise in the price of the domestic good is smaller as can be seen from Table 2. In this case workers accept a reduction in nominal wages because the cost of living declines along with the decrease in domestic prices. However, imports do not change in price, so that the fall in nominal wages is less than the decline in the price of the domestic good. This comes down to saying that the real producers' wage rises, but less than in the case of NWR. It follows that the decline in output and employment is also smaller under RWR than with NWR. Consequently, there will be more room for an increase in private consumption, while the real exchange rate depreciation is more pronounced.

Table 1: Fiscal contraction under NWR

period → variable ↓	0	1	2	3	5	10	NSS
c	1.63	1.62	1.62	1.62	1.66	1.84	2.73
c_d	2.08	2.05	2.04	2.05	2.10	2.35	3.49
c_m	0.89	0.89	0.89	0.90	0.91	0.98	1.45
c_m*	1.12	1.08	1.07	1.07	1.11	1.27	1.89
v	0.59	0.58	0.57	0.57	0.59	0.67	1.00
l	-1.79	-1.65	-1.51	-1.38	-1.15	-0.69	0
k	0	-0.18	-0.33	-0.45	-0.61	-0.74	0
w	0.91	0.75	0.61	0.48	0.28	-0.03	0
m	0.91	0.89	0.88	0.88	0.89	0.98	1.54
b	0	-0.01	-0.04	-0.07	-0.12	-0.22	0

Percentage deviations from ISS (except b, for which it is 100x the absolute deviation).

The labour-market adjusts slowly under RWR with the target real wage rate (w_d) equal to the equilibrium consumers' wage rate (w_c) in the initial steady state. The real consumers' wage decreases gradually and because the wedge does not change very much the real producers' wage declines at a very moderate rate too. First employment rises, but as the decumulation of capital proceeds unemployment increases. The negative capacity effect takes over at t=4. Labour, capital and output, then decline until in the new steady state (NSS) factor proportions are the same as initially. As a result the real producers' wage returns to its initial level. Firms are in a position to shift the burden of the demand shock backwards at the cost of unemployment. The long-run loss in output goes at the expense of private consumption. As appears from Table 2 private consumption declines after the initial rise on impact of the adverse demand shock. Therefore, the real exchange rate appreciates from t=1 until the new steady state is attained eventually. It should be observed that the long-run consumers' wage rate in NSS is lower than the target wage rate. Therefore, workers might adapt the target wage downward after sufficient time has elapsed. This implies that there could be full employment in the very very long run if the economy would be hit by adverse shocks only. This seems a fair description of what real wage rigidity is supposed to mean.

Finally, it should be noted that the welfare effects of an unfavourable demand shock are ambiguous. Under NWR private consumption increases at the expense of government spending. If government expenditure yields direct utility the welfare implications depend on the specification of the utility function. Under RWR the situation is worse, because the natural rate of unemployment

Table 2: Fiscal contraction under RWR

period → variable ↓	0	1	2	3	5	10	NSS
c	2.28	2.26	2.24	2.21	2.16	2.02	1.36
c_d	2.94	2.92	2.88	2.84	2.76	2.57	1.74
c_m	1.16	1.16	1.16	1.16	1.14	1.09	0.73
c_m^*	1.66	1.63	1.60	1.57	1.50	1.38	0.95
v	0.88	0.86	0.85	0.83	0.80	0.73	0.50
l	-0.64	-0.61	-0.60	-0.60	-0.63	-0.71	-1.07
k	0	-0.06	-0.12	-0.17	-0.25	-0.42	-1.07
w	0.32	0.28	0.24	0.22	0.19	0.15	0
w_c	0	-0.04	-0.07	-0.08	-0.10	-0.12	-0.19
m	1.33	1.32	1.31	1.29	1.26	1.17	0.77
b	0	0.04	0.07	0.10	0.13	0.15	0

Percentage deviations from ISS (except b, for which it is 100x the absolute deviation).

increases.

3.3. Sensitivity of the results

It may be of interest to consider the sensitivity of the results for different values of the crucial parameters. As shown in Van de Klundert and Van der Ploeg (1988) under RWR the transition path and the long-run equilibrium values of the variables are rather sensitive with respect to changes in the wage flexibility parameter χ. Here we concentrate on the role of the elasticity of factor substitution (ρ). The effects of a different value of ρ on the time path of unemployment (Δu = change in unemployment as an percentage of employment in the initial steady state) is illustrated in Figure 2a (for NWR) and Figure 2b (for RWR). Note that the scales on the vertical axes are different. An elasticity of 0.65 is used in the numerical examples discussed in Section 3.2.

The impact effect of an adverse demand shock on unemployment is higher for higher values of the substitution elasticity, which will not come as a surprise. At a higher value of ρ employment declines more when the real wage rate rises. However, labour market adjustment will be faster for higher values of the elasticity of substitution as appears from Figure 2a. The two lines intersect between t=4 and t=5. Under RWR the picture is more complicated. The capacity effect has a larger influence for lower values of ρ. Profitability will be squeezed more in the latter case, which leads to a more severe decapitalization. As shown in Figure 2b unemployment rises faster and attains a higher long-run equilibrium value for $\rho = 0.35$ compared with the original value of 0.65. As a result of the difference in impact and transition effects unemployment will be higher in the case of lower substitutability after period t=9. These results confirm the view expressed in the Introduction that decapitalization becomes more serious as the possibility of factor substitution is more limited.

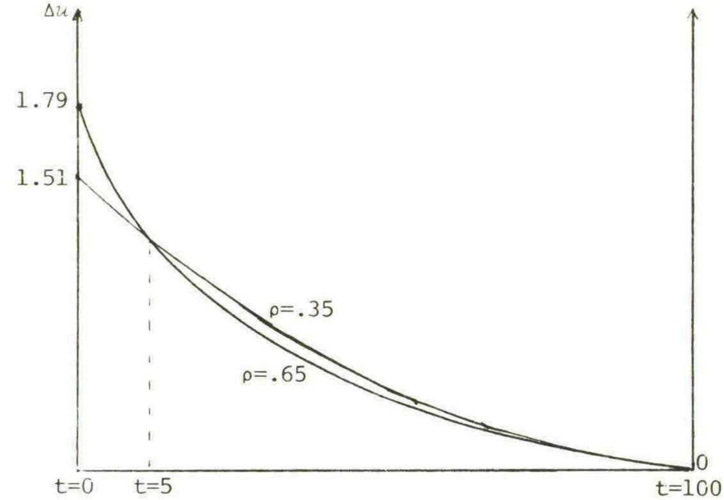

Figure 2a

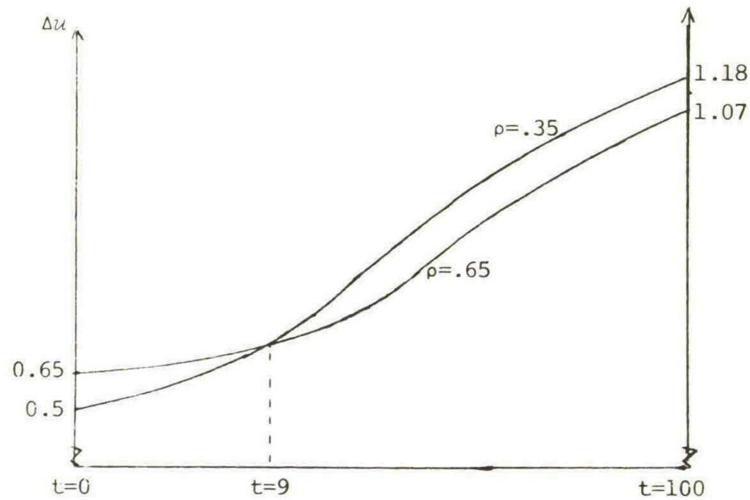

Figure 2b

4. CONCLUSIONS

The problem of unemployment in small open economies like the European countries cannot be analysed properly if capital accumulation is ignored. Under nominal wage rigidity (NWR) an adverse demand shock leads to a protracted period of real wage adjustment because of decapitalization as profits are squeezed. Eventually the real wage rate falls below its initial steady state level before the long-run equilibrium is restored. With real wage rigidity (RWR) the situation is even more dramatic. After an initial period of adjustment with unemployment declining as a result of wage moderation capital decumulation will become the dominant factor. Firms respond to high wages by reducing capacity and unemployment rises after a certain point in time. In the long-run the natural rate of employment or NAIRU will be higher while real producers' wages will be equal to the initial steady state value.

There appears to be a certain sensitivity of the results with respect to changes in the elasticity of factor substitution.A lower elasticity implies a lower impact effect on unemployment in both cases of wage rigidity. However, under RWR the natural rate of unemployment will be higher in the new steady state for lower values of the elasticity of factor substitution.

Future research may focus on strategic behaviour of unions and firms, which learn from past experience.

APPENDIX

The specification of the functions applied in the numerical examples is given below. We start with functions on the demand side.

$$(A.1) \qquad u_1 = \gamma_c \log \tilde{c}$$

$$(A.2) \qquad u_2 = \gamma_m \frac{\tilde{m}^{1-\zeta}}{1-\zeta}$$

$$(A.3) \qquad v = \left\{ \alpha^{\frac{1}{\eta}} c_d^{\frac{\eta-1}{\eta}} + (1-\alpha)^{\frac{1}{\eta}} c_m^{\frac{\eta-1}{\eta}} \right\}^{\frac{\eta}{\eta-1}}$$

Eqution (A.3) can be used to derive

$$\Phi = \frac{(1-\alpha)}{v^{\eta}} \{\alpha + (1-\alpha) v^{1-\eta}\}^{-1},$$

with as its foreign analogue

$$\Phi^* = (1-\alpha^*) v^{\eta^*} \{\alpha^* + (1-\alpha^*) v^{\eta^*-1}\}^{-1},$$

and

$$\Omega = \{\alpha + (1-\alpha) v^{1-\eta}\}^{\frac{1}{1-\eta}}$$

On the supply-side the following specifications are used

$$x = \varepsilon \{\beta\, l^{\frac{\rho-1}{\rho}} + (1-\beta)\, k^{\frac{\rho-1}{\rho}}\}^{\frac{\rho}{\rho-1}}$$

$$h = i\,(1 + \xi \frac{i}{k})$$

$$\phi = \phi_0 \log \left\{ \frac{u_n}{l_s - l} \right\}$$

The numerical values of the parameters, exogenous variables and initial conditions are given in table 3.

Table 3: Numerical specifications

Parameters:

$\gamma_c = 0.5$, $\gamma_m = 0.05$, $\zeta = 2$, $\sigma = 0.05$, $\eta = 2$, $\alpha = 0.75$, $\alpha^* = 0.90$, demand-side parameters

$\xi = 4$, $\delta = 0.1, \phi_0 = 0.005$, $\varepsilon = 1$, $\chi = 0.5$, $\beta = 0.6$, $\rho = 0.65$, supply-side parameters

$\psi = 0.1$, degree of capital mobility.

Exogenous variables:

$g = 0.2$, $\theta = 0.1$, demand-side policies

$u_n = 0.05$, $w_d = 0.944$, supply-side policies

$r^* = 0.15$, $p^* = 0.1$, $c^* = 10$, foreign variables.

Initial conditions:

$b(0) = 0$, $k(0) = 1.004$, $\dfrac{w(0)}{m(0)} = 1.322$ (for NWR), $w_c(0) = w_d$ (for RWR).

Roots (real parts) in the initial steady state (NWR):

0.34274	0.20852	0.16037
-0.10427	-0.10427	-0.24995

Roots (real parts) in the initial steady state (RWR):

0.30000	0.21732	0.21732
-0.05682	-0.58343	-0.24268

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